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NORTH DAKOTA GEOLOGICAL SURVEY
UNIVERSITY, N. DAK.

FIRST BIENNIAL REPORT

OF THE

COMMISSIONERS

OF THE

Geological and Natural History Survey

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STATE OF WISCONSIN.

GEOLOGICAL AND NATURAL HISTORY SURVEY

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Director and Superintendent.

LETTER OF TRANSMITTAL

Madison, December 23d, 1898.

HONORABLE EDWARD SCOFIELD,
Governor of Wisconsin.

SIR:—I present herewith, for transmission to the legislature, the first biennial report of the Commissioners of the Geological and Natural History Survey. This survey was authorized by chapter 297 of the laws of 1897, by which there were appointed as commissioners: The governor of the state; the state superintendent of public instruction; the president of the state university; the president of the Commissioners of Fisheries; and the president of the Academy of Arts and Sciences. The commissioners met for the first time on May 7th, 1897, and organized by the election of the president of the state university as president of the board of commissioners; Honorable E. E. Bryant, president of the Commissioners of Fisheries, as vice-president; and Professor C. Dwight Marsh, president of the Wisconsin Academy, as secretary. Professor E. A. Birge, of the state university, was elected as superintendent of the Survey. During the first year the superintendent served without compensation, giving to the work of the Survey only such time as was available outside of university duties and such time as was available in vacation after the closing of the summer school. In 1898 he gave the entire summer vacation to the work of the Survey, resigning his position in the summer school, and was paid for his services during the year the sum of $300; being the same amount that he would have received had he taught in the university summer school.

The legislature appropriated for the use of the commission the sum of only $5,000 a year for two years. It was therefore impossible for the commission to undertake all of the work which it was authorized to do by the terms of the law which created it. It was determined, therefore, to concentrate attention on a few of the more important and pressing subjects of investigation. First in this list was a study of the building and ornamental stones of the state. Dr. E. R. Buckley was appointed as assistant geologist of the Survey, on the recommendation of the superintendent, and has given his entire time to the preparation of a report on the building stones of the state, considered both from the scientific and the industrial aspects. This report is now completely in type and is ready to be issued, with the exception of the colored plates illustrating the texture and natural colors of the more important building stones of the state. These have been delayed in printing, but will be completed in a very short time, when the report will be issued.

The commissioners determined that the next subject in order of importance was the completion of the geological survey of the state. As was pointed out to the legislature when the bill establishing the Survey was under consideration, a large area in the north central part of the state has been studied either not at all or very imperfectly, owing to the fact that at the time of the last geological survey the region was almost wholly without inhabitants. Dr. Samuel Weidman was appointed assistant geologist and directed to begin work in the region about Wausau and Merrill, an area in which little or no geological work had been done. In this district also a considerable amount of money has been expended in the search for iron and it seemed worth while, therefore, to investigate the area from economic reasons. Dr. Weidman has studied about one thousand square miles in this district, having spent two seasons in the field, and is now beginning to prepare his report on the district.

The investigation of the lakes of the southern and eastern part of the state has formed the third subject of investigation. In this important field a beginning only has been made by the preparation of careful hydrographic maps, showing the outlines of the lakes and especially the depth of water in them. It is designed to continue and extend this investigation to the biology and chemistry of these lakes and of the streams and wells of the same region.

Application was made to the commissioners of this Survey by the forestry commissioners of the state for aid in the preparation of a report on the forestry conditions of northern Wisconsin. Accordingly, an arrangement was made with the United States Department of Agriculture by which Mr. Filibert Roth was assigned to duty in Wisconsin; the United States Department of Agriculture paying his salary, and the Wisconsin Survey paying his traveling and other expenses. As a result of his investigation, the first bulletin of the Survey was published in 1898, On the Forestry Conditions of Northern Wisconsin. Five thousand copies of this bulletin were published and most of them have been distributed by the Forestry Commission, and by the Survey, to the citizens of Wisconsin. It is hoped that the facts and recommendations of this report will aid the forestry commissioners and the legislature in the formulation of wise legislation on this important subject.

The work of the Survey has been carried on in several other directions, but on a decidedly smaller scale. The superintendent of the Survey and Professor Marsh have devoted some time to the beginning of a biological survey of the Wisconsin lakes. Professor L. S. Cheney of Madison assisted Mr. Roth for some time in the field work preliminary to the preparation of his report, and during the summer of 1898 has carried on the field work necessary for the preparation of an educational bulletin on the forest trees of the state. Professor D. P. Nicholson of Appleton and Professor G. L. Collie of Beloit have begun the preparation of reports on the physical geography of different regions of the state. Professor Collie's work has been done in the southern region and Professor Nicholson's in the northern lake region of the state. Professor R. D. Salisbury of Chicago has prepared a report on the geology and physical geography of the Dells and Devil's Lake. None of the persons named in this paragraph have received for these services anything beyond the repayment of their necessary expenses while in the field.

The publications of the Survey are issued in three series of bulletins:

1. The economic series, in which are reported the results of investigations of economic importance.

2. The scientific series, in which are published the results of investigations whose interest is scientific rather than economic.

3. The educational series, in which are published the results of studies of the resources and natural history of the state, presented in such form as to make them available for use in the schools.

Two bulletins have already been issued and distributed:

Bulletin I.—On the Forestry Conditions of Northern Wisconsin, by F. Roth, to which reference has already been made.

Bulletin II.—The first bulletin of the scientific series: On the Habits and Instincts of the Solitary Wasps, by G. W. and E. G. Peckham.

Two other bulletins are in type and about ready for distribution:

Bulletin III.—A scientific bulletin: On the Pre-Cambrian Igneous Rocks of the Fox River Valley, by S. Weidman.

Bulletin IV.—On the Building and Ornamental Stones of Wisconsin, by E. R. Buckley.

Through the courtesy of the Secretary of State the finances of the Survey have been administered through his office. Claims against the Survey are made out on a proper form, are approved by the superintendent of the Survey, and are countersigned by the president of the commissioners. They are then sent to the secretary of state, who audits the account and pays it by warrant, in the same way that other claims against the state are paid. A report from his office is appended showing the nature and amount of the warrants drawn against the appropriation for the Survey. From the report of the superintendent which is given herewith, it will be seen that about one-quarter of the $10,000 appropriated to the Survey has been expended in the preparation of the building stone report; more than one-fifth has gone into the geology of the northern part of the state; about one-eighth has been expended in the lake survey; on the investigations of the forests there was expended about $700; and the remainder of the appropriation has been distributed in paying the expenses of the minor investigations mentioned above and in defraying the cost of administration. Something more than a thousand dollars of the appropriation is still in hand and will be used for defraying the expense of completing some unfinished investigations on the building stones, and for carrying on the work of the assistant in geology during the coming winter.

The commissioners desire to give cordial recognition to the assistance which the Survey has received from various scientific men in the state, either almost or wholly without compensation. Professor C. R. Van Hise has acted as consulting geologist to the Survey, giving much time and thought to directing and planning the work of geology and counseling with the superintendent in other matters. His services have been given entirely beyond compensation beyond the repayment of actual expenses during short trips into the field to supervise the work of the assistants of the Survey. The gentlemen named in the earlier part of the report, Professors Salisbury, Collie, Nicholson, Marsh, and Cheney, have devoted much time and labor to carrying on the investigations which they have undertaken, and have received from the Survey nothing more than the repayment of expenses while in the field.

The commissioners feel that much work has been accomplished by the Survey,—an amount quite beyond what might have been expected from the meager appropriations made. It is obvious, however, as is pointed out in the report of the superintendent appended hereto, that the objects of the Survey cannot be met, even with a fair degree of completeness, unless the amount of money appropriated to this purpose by the state is very considerably increased. The commissioners desire to maintain two geological parties in the field; to undertake the investigation of the clays and clay industries of the state; to begin the chemical and biological investigation of the waters of the southern part of the state; and to devote a reasonable sum of money to the completion of the topographical map of the state. If these plans are to be carried out, an appropriation of from $15,000 to $17,000 annually will be needed by the Survey.

C. K. ADAMS,
President of the Board of Commissioners.

REPORT OF THE SUPERINTENDENT OF THE SURVEY.

To the Commissioners of the Geological and Natural History Survey.

GENTLEMEN:—I submit herewith my report as director of the Survey under your charge, for the year ending October 29, 1898. I have extended the report somewhat beyond the term of one year, so as to include the general work of the biennial term, which closed Dec. 31.

I. PERSONNEL OF THE SURVEY.

The following persons have been employed by the Survey during the past year, with compensation stated in each case:

E. A. Birge, director, receives $300.00 for services during the year 1898, besides expenses in the field. No compensation during 1897.

C. R. Van Hise, consulting geologist, without compensation, except expenses while in the field.

E. R. Buckley, assistant geologist, $800.00 per annum, and expenses while in the field.

S. Weidman, assistant geologist, $800.00 per annum, and expenses while in the field.

L. S. Smith, in charge of hydrography, paid $0.50 per hour for office work, and $5.00 per day and expenses while in the field. In the field between two and three weeks.

H. M. Tripp, surveyor, employed about six weeks of the winter at $70.00 per month, and expenses.

George L. Collie, of Beloit, engaged in writing report of last summer's work, has received no compensation.

D. P. Nicholson, of Appleton, employed about a month during the summer, receiving $3.50 per day in lieu of expenses.

L. S. Cheney, employed during the summer, receiving no compensation beyond actual expenses.

C. Dwight Marsh, of Ripon, gave some time to the hydrographic survey of Green lake and a short time during the summer to biological lake work. He received $3.50 per day in lieu of expenses.

Besides these persons, there have been employed various persons as rodmen, etc., in surveying, at various small compensations and for limited amounts of time. Miss F. K. Denniston has done most of the drawing for the building stone report, being paid various rates, according to the nature and amount of service. Prof. W. W. Daniells has been employed to make about twenty analyses of rock for the building stone report. I ought not to omit to mention the services of Mr. E. C. Chandler, of Ripon, who has devoted much time, without compensation, to preparing the map of Green lake, and through whose aid the results are far more accurate than they would otherwise have been.

II. FINANCIAL STATEMENT.

By the kindness of the secretary of state, the Survey has been permitted to send its accounts to that office to be audited. No money has been drawn from the treasury directly by the officers of the Survey, but the claims as presented have been endorsed by the superintendent of the Survey, counter-signed by the president or vice president of the board of commissioners, and then have been sent to the secretary of state's office, where they have been audited and the necessary warrants have been drawn upon the treasury. The director of the Survey is especially grateful to have been able to conduct the business affairs of the Survey in this manner.

The Survey has spent thus far, during the two years of its existence, a little more than $8,500.00 out of the $10,000.00 appropriated to it. A detailed statement of the finances will appear from a report made by the secretary of state, but the general direction in which the money has been expended can be seen by the following summary of my own accounts. My books show that the following sums have been expended for various purposes, during the biennial period up to Dec. 31, 1898, and including the expenses for December:

Building stone	$2,418 37
Geology	2,030 19
Forestry and Botany	614 09
Lake survey	1,304 84
For work on forest trees	293 88
Physical geography	381 79
Lake biology	605 57
Report on geology of Devils Lake	400 00
Administration	441 76
Drawings for bulletin No. II	60 00
	$8,565 16

The report from the secretary of state shows that warrants were paid up to October 30, 1898, to the amount of $6,871.61; the difference between this sum and that reported in the foregoing account being due to the fact that warrants are included in my account which were paid at a later date than that at which the secretary of state closed the year's accounts.

There was thus a balance on January 1, 1889, of $1,449.51. Of this sum there is appropriated to the completion of the bulletin on forest trees $200, and there are bills outstanding amounting to about $85. About $150 will be needed to complete the lake survey, so that there is at this date a free sum of about $1,000. It has been my intention, as directed by the commissioners last year, to have a sufficient balance on the first of January to continue the geological work of the Survey until such a time as any appropriations made by the next legislature may become available. I have, therefore, reserved sufficient money to continue this work of the Survey without interruption for three months. I estimate that the following sums will be necessary for this purpose:

For Dr. Weidman, who will be engaged in the preparation of his report on the region which he has surveyed, salary and expenses	$350 00
For Dr. Buckley, who will be occupied in making a somewhat elaborate series of tests of building stones, in order to complete the observations embodied in his report, there will be needed for salary	200 00
and for expenses	250 00
Total	$800 00

Some small sums will be necessary for continuing the office-work, and any other balance I shall use in bringing together apparatus, etc., necessary for the work of the coming summer.

III. WORK OF THE SURVEY.

A. I wish to acknowledge with special gratitude the services to the Survey of Prof. C. R. Van Hise. He has directed the work of the geological assistants, and has devoted much time to this service, and besides has constantly advised with me on all matters pertaining to the Survey, whether included in the department of geology or elsewhere. His services have been given to the Survey without compensation, the Survey only repaying his actual expenses during the time that he has spent in supervising, in the field, the work of Dr. Weidman and Dr. Buckley.

B. Building Stone Report.—The preparation of the report on building stones was commenced by Dr. E. R. Buckley about the middle of June, 1897. The following five months were devoted almost exclusively to an examination of the more important quarries in various parts of the state. All quarries located in areas where there were possibilities of securing good building stone were visited. The character of the stone as it occurred in the quarry, the history of its development, and present condition were all carefully noted. The facilities which were at hand for quarrying were considered, and estimates of the possibilities of the future development of the quarry were made. Where the company owning the quarry possessed suitable facilities for cutting and dressing samples of the stone, requests were made that samples 8 inches x 8 inches x 8 inches be dressed and sent to the Survey. It was also requested from each of the quarries that either two-inch cubes or rough samples of the stone, for testing purposes, be forwarded at the earliest convenience.

In nearly all cases either two-inch cubes or rough samples of the stone were sent in for testing, and in many cases dressed samples were provided. Nearly fifty quarries sent samples to the Survey for testing and for exhibition in the laboratory of the Survey. These samples may be seen by any one interested in the building stones of the state at any time, by calling at the rooms of the Survey.

The last month of 1897, and the first two months of 1898, were devoted to testing the rough samples of stone which were sent to the Survey during the preceding summer and fall. The succeeding ten months have been devoted to the compilation of the results of the field examination and the laboratory tests.

The report, as it now appears as Bulletin No. IV of the Survey, consists essentially of three parts: a consideration of the building stones as they occur in the quarries, a discussion of the physical, chemical, and mineralogical properties of the stone, and a consideration of the manner in which the stone, which has already been used from these quarries, has stood the requirements of good building and monumental stone.

The first part of the report comprises a general discussion of the demands and uses of stone, the necessary considerations in the selection of stone, and the means of determining the value of stone for building or other economic purposes. The second part of the report comprises a brief geological history of Wisconsin, and the description of the areas and individual quarries from which building and monumental stones have been lately exploited. The last chapter of Part 2 is a discussion of the physical tests, and embodies a series of tables showing the results of all the physical tests made on the different stones from Wisconsin. Accompanying these tables are several tables which give the results of tests on building stones from other states; inserted for comparison. An examination of these tables is very interesting in showing that Wisconsin not only has the strongest known granite and limestone, but also possesses building materials which are equal if not superior in durability to others now used in the state and imported from other parts of the country.

The great variety of granites which are to be found in different parts of the state indicates that in the future monumental stones used in this state will be largely obtained from the home quarries. Many of the granites now have an enviable reputation in the markets of the United States.

The Lake Superior brownstone is well adapted for building or other constructional purposes, and will be used probably much more largely in the future than it is at present.

The limestones which are quarried from the Niagara formation in the eastern part of the state, and those quarried from the Trenton in the vicinity of Green Bay, and the Lower Magnesian limestone in the western part of the state are well adapted to most purposes of construction, and will, in the future, as in the past, supply a very large part of the demand for stone for constructional purposes.

In this report an attempt has been made to give our readers an idea of the color and texture of the more important kinds of granite and brownstone now quarried in the state, by the insertion of colored lithographs, which accompany the description of the granite and brownstone from the different quarries. These lithographs are very accurate reproductions of the polished faces of the granite, and the sawed faces of the brownstone. They should prove valuable to architects and builders in selecting stone, as well as in showing the people in general the variety and exceptional beauty of the building and ornamental stones of Wisconsin.

The report also contains numerous half-tone cuts of the more important buildings and monuments constructed out of Wisconsin stone. These are intended to convey to the reader, in a limited way, an idea of the extent to which Wisconsin stone has been used and the pleasing architectural effects produced thereby. In the back part of the report numerous plates are inserted which illustrate the results of a number of the laboratory tests. It is thought that they will prove of service in showing the manner in which the different kinds of stone are affected when subjected either to more than the ultimate strength, or to extremely high temperatures. Accompanying these plates is a series of photographs of thin sections of the different kinds of stone, as seen through the microscope. These plates are important in showing the shape of the individual grains which make up the rock, and the manner in which they are united to their neighbors. The strength and durability of the rock depend very largely upon these facts.

A general map of Wisconsin, showing the distribution of the different kinds of rock and the location of the more important quarries, will be of value to quarrymen and other parties interested in the exploitation of the stone for economic purposes. The sketch maps, which are found throughout the report, locate more definitely the different quarries, and show more accurately the distribution of the formations in the areas outlined.

In general, it is thought the report will modify the conception which the people of this and neighboring states have of the importance of the stone industry of Wisconsin. It is very evident that few people know how extensive the valuable building and ornamental stones of Wisconsin are, and it is hoped that this report will result in a more extensive development of the stone industry of this state.

C. Dr. Weidman spent the winter in platting and working up the results of his last summer's field work in the region about Wausau and Merrill, and in the preparation of a bulletin on The Volcanic Rocks of the Fox River Valley, the field work for which was done before he became assistant on the Survey. He has spent the summer in completing the field work in the region above named. This area was left almost untouched by the first geological Survey, and is one of great geological complexity, as well as a region whose geology afforded some hope of economic results. As yet, no discoveries of economic importance have been made, and the time has been devoted to working out the very difficult geological structure of this region.

The Wausau district includes a region with a radius of 25 or 30 miles about the city of Wausau. It is proposed to make a thorough geological survey of the district, requiring detailed field-work on the whole area considered, and a careful study of the facts. With this purpose in view, field-work in this district, under the direction of the Survey, was begun the latter part of June, 1897. Previous to this, however, about two months of field-work had been done in the near vicinity of Wausau, by E. R. Buckley and S. Weidman, in the autumn of 1895 and the spring of 1896, under the direction of the geological department of the University of Wisconsin.

The field-work of the former state geological Survey in this region was of a very general nature. Prof. R. D. Irving spent a few days in the vicinity of Wausau, in the summer of 1874, and his notes and specimens were supplemented by those of A. C. Clark, taken in 1879. The observations of Irving and Clark were confined principally to traversing the Wisconsin river and two of its tributaries, the Eau Claire and the Big Rib rivers.

Within the last 20 or 25 years, or during the time which has elapsed since the former general survey was made, the region about Wausau, in Marathon and Lincoln counties, as in many parts of north-central Wisconsin, has become thickly settled with prosperous farmers. Numerous and well traveled roads net the country, and the clearing of the land into farms has exposed to view many outcrops of rock that would have been difficult, and even impossible to discover in the formerly wooded country. In the making of wells at the farm houses, the solid crystalline rock is met with at various depths below the surface, and thus the wells furnish an important means to the geologist in gathering information in the field. The settlement of the rural districts, therefore, has not only facilitated work in the field, but has also brought to light many facts of geology that were formerly hidden. The principal means of travel in the prosecution of the field study is the bicycle, and it has been found that by traversing every road in the district by wheel, and examining the rock from the wells and along the streams, the areal distribution of the different kinds of rock can be worked out with sufficient accuracy, at a small cost and with considerable rapidity.

The part of the Wausau district in which the field work is almost completed covers about 900 square miles in Marathon county, and about 100 square miles in Lincoln county. The rocks of this district are of pre-Cambrian age, and most of the formations are intricately folded, and all very much metamorphosed. The different formations of these old crystalline rocks have been outlined, their areal distribution indicated on the maps, and their relative age and relations to one another has been learned.

In carrying on the field work, all the outcrops of rock are visited and specimens collected, which are described in field note-books, and located upon maps. Something over 1,500 specimens from different outcrops have already been collected in the district. From about 500 of the specimens thus collected thin sections have been made, for the purpose of studying the rocks under the microscope, to determine their mineral composition and texture. It is also important that chemical analyses of many of the rocks be made. By combining the detailed field study of the different rock formations and the laboratory study of the rock by the microscope and chemical analysis, the geology can be worked out on a firm scientific basis.

It is in this connection that the reliance of mining geology and the economic development of the mineral resources of a region upon the collection and discussion of the facts of geology from a purely scientific standpoint can best be exemplified. It has been estimated that about $75,000 have been invested in the mining industry about Wausau. This expenditure has been made without any adequate knowledge of the nature and origin of ores, or of the nature and relations of the rock formations on which this large amount has been spent. It is safe to say that nearly all of the amount invested represents just so much loss of labor to the state. The numerous and expensive abandoned mines and test-pits that one meets with in the Wausau district are constant reminders of the needless expenditures on the part of individuals, which a scientific examination of the region by a geological survey would have prevented.

Dr. Weidman's report on the Volcanic Rocks is now wholly in type, and will be issued very soon. It is a careful scientific study of the rocks so extensively quarried at Berlin, Waushara, and Utley.

D. The third important piece of work done during the past year has been on the lakes in the southern and southeastern part of the state. These lakes are the most valuable economic resource of this region of the state, which can be investigated by this Survey, and their study has seemed to me one of the most important subjects which the Survey could undertake. The state is also spending on these lakes, through the Commissioners of Fisheries, considerable sums of money annually, and accurate information of them is needed, for this reason, if for no other. In beginning the work, I found that there was very little accurate knowledge regarding the lakes, and that even the people residing near them knew very little regarding their depth or other characteristics below the surface. With the approbation of the Commission, I determined last winter to begin a series of soundings through the ice, with the view of obtaining a more accurate knowledge of the area and topography of the lakes than we have hitherto had. Mr. H. M. Trippe spent about six weeks of the past winter in such work, making a survey of some 24 lakes, including the more important lakes from Elkhart lake on the north to Lake Geneva on the south. His field notes were platted, and maps were drawn by Prof. L. S. Smith, who has had charge of the hydrography, and has devoted much time without pay to the supervision of the work of field parties.

A considerable sum of money had been reserved for field work by Dr. Buckley, who had expected to extend his field observations during the summer, in addition to the preparation of his report. When it became apparent that the time at Dr. Buckley's disposal would not permit this additional field work, I directed Prof. Smith to extend this lake survey to the Waupaca region, and also to complete some points in the survey of the other lakes, in which the maps proved to be deficient, using part of the funds for this purpose, not needed by Dr. Buckley.

This work was especially necessary from the fact that the maps of the lakes, contained in county atlases or government plats, are, in many cases, grossly imperfect, so that it was almost impossible to make the results of Mr. Trippe's survey fit on the outlines of the lakes, as obtained from these sources. As a result of this work, a large number of lakes have been surveyed, including the following list:

Chain of lakes, Waupaca.

Elkhart lake.

The lakes in the neighborhood of Oconomowoc and Waukesha, including Lac la Belle, Fowler, Oconomowoc, Okauchee, North, Pine, Beaver, Nagowicka, Upper and Lower Nashotah, Upper and Lower Nemahbin, Crooked, Otis, Genesee, Silver, and Pewaukee lakes.

Lake Beulah, Booth's and East Troy lakes.

The Lauderdale lakes.

Delavan lake.

Lake Geneva.

Lake Mendota.

Green lake.

These lakes have been surveyed accurately enough to give ten-foot contour maps. Through the aid of the Department of Engineering in the University of Wisconsin, a survey of Lake Mendota has been completed sufficiently accurate to permit five-foot contours, and the Geological Survey, through Professor Marsh, of Ripon, has completed a survey of Green lake. This is mapped on twenty-foot contours, the slopes being so steep that a smaller interval is not advisable. Altogether, if we enumerate the single lakes at Waupaca, Lake Beulah, and Lauderdale, we have surveyed 50 lakes.

It will be seen that we are now in possession of reasonably accurate hydrographic data regarding most of the more important deeper lakes of southeastern Wisconsin, with the exception of three of those about Madison.

I have not begun a similar survey of the more shallow lakes, such as Lakes Puckaway and Koshkonong; nor have I been able to begin work on Lake Winnebago, on account of its great size and the consequent expense attending the survey. During the coming winter I hope to make a survey of the Madison lakes through the ice, but I fear that the money at the disposal of the Survey will not permit us to begin work on Lake Winnebago. This lake, at once the largest and most productive in fish of the inland lakes of the state, deserves to be carefully studied and I greatly regret that the funds at the disposal of the Survey have compelled us to restrict our work hitherto to the smaller lakes. The Survey should undertake a thorough survey of this lake, if the means are at our disposal, and also should extend it to the remaining lakes of southeastern Wisconsin, which by size, depth, or economic importance demand attention.

One of the maps of the lakes has been issued in a small edition, that of Lake Geneva. The maps of the other lakes are all of them drawn in pencil, and most of them inked, so that they will be ready for publication in a very short time.

These maps will serve as a basis for a very large amount of work in coming years. It is my hope and expectation to issue an illustrated bulletin, descriptive of the topography, etc., of these lakes, during the coming year, in which these maps will be used. The smaller lakes will be engraved for such publication on a larger scale than that which is employed in the general sheets which we are now issuing. The maps will also guide us in work of another character, of which I shall speak in a later part of the report.

E. To my great regret, Prof. Geo. L. Collie, of Beloit, was unable to continue field work on the physical geography of the southern part of the state during the past season. He has, however, completed and sent in the first draft of a general account of the physical geography of this region, which will doubtless be completed and published during the coming season, though it may be necessary to give some more time to that work in order to make the report satisfactory to him.

F. Prof. D. P. Nicholson, of Lawrence University, spent about a month in field work on the lake region of Northern Wisconsin. This triangular region in the north part of the state, whose center is not far from Minocqua, offers extremely interesting geological problems, of which Prof. Nicholson has undertaken the survey. The work of this season was merely preliminary to a more extended study of the district during next summer.

G. Prof. L. S. Cheney, of the University of Wisconsin, spent the summer in field work, preliminary to the preparation of an illustrated bulletin on the structure and distribution of the forest trees of the state. He has completed the necessary field work for this paper, and expects to submit his report during the coming season.

H. Prof. C. Dwight Marsh, of Ripon, has devoted some time to the hydrographic survey of Green lake, and has already collected material for a study of the biology of the crustacea of of some of the lakes. The amount of field work done by Prof. Marsh has, however, been greatly reduced by the fact that much of his summer vacation was spent in teaching.

I. Prof. R. D. Salisbury, of the University of Chicago, has prepared a somewhat elaborate bulletin on the physical geography and geology of the Dells and of Devils lake. For the payment of field expenses in preparing such bulletin, the sum of $400.00 was appropriated by the Survey, the money to be paid when the manuscript of the report was submitted. Prof. Salisbury has transmitted his report to me and I shall expect to publish it during the coming year.

J. The Survey has made a not inconsiderable demand on my own time during the past year, and my work as director has seriously interfered with the scientific investigations which I had hoped to conduct. It has been necessary for me to revise the manuscripts of four publications, and to read proof on the two that have been issued, and of the others, as far as they are already in print. This work, together with the general supervision of the field parties and the office work, has occupied a very large share of the time which I could devote to the work of the Survey. I have, however, carried on regular observations of the temperature of the lakes at Madison, and in the neighborhood of Oconomowoc, with the view of publishing a paper on this important subject, and have also collected the material for the study of the lower life, both plant and vegetable, found at different depths of the open waters of these lakes. This material I have not yet been able to touch, but shall hope to work it up during the coming winter, and to complete the paper on Lake Temperatures. I have been visiting the Oconomowoc lakes at regular intervals since last spring; have made one trip to Lake Geneva and other lakes in that region; and I have spent about ten days in a trip to the northern part of the state, accompanying Prof. Nicholson in his work on the lake region for about a week, and continuing my own field work there. It was a great disappointment to me not to be able to spend considerably more time among the northern lakes, but I was obliged to postpone detailed work in that region until another season.

IV. PUBLICATIONS OF THE SURVEY.

The commission determined to issue its reports as independent bulletins, and to print these in three series. The first, an economic series, which treats of subjects of economic importance; the second, the scientific series, which discusses matters of scientific, rather than immediately practical interest; and third, an educational series, which contains papers whose main object is to extend and popularize knowledge, and especially to present it in such form as to make it useful in the educational institutions of the state. Two bulletins have thus far appeared, the first of the economic series, and the first of the scientific series. The first economic bulletin is entitled On the Forestry Conditions of Northern Wisconsin, by F. Roth, Special Agent of the United States Department of Agriculture, pp. 78, one map. This bulletin was prepared at the request of the State Board of Forestry. On the joint request of that Board and this Survey, Mr. Roth was detailed by the Department of Agriculture to make the survey and prepare the report, the Survey bearing his expenses and the Department of Agriculture paying his salary. Five thousand copies of this report were printed, of which 2,000 were for the use of the Forestry Commission, the remainder being for the use of the Survey.

Mr. Roth's bulletin contains the result of observations made rapidly during a period of three months and extending over the entire northern part of Wisconsin. It is therefore necessarily incomplete in its detail, but it represents in a singularly attractive and convincing manner the present condition of our forests, showing the amount to which they have already been exploited, giving estimates of the amount of timber still remaining, and especially calling attention to the enormous loss of wealth which the state has suffered through carelessness, resulting in destruction by fire. It gives also for the first time some idea of the length of time during which our lumber industries may be expected to continue on their present basis and affords some indication of the changes in the character and direction of these industries, which will be necessary as the supply of conifers in the state is exhausted and the lumber industries must turn to the hard woods. It gives also valuable suggestions regarding the possibilities and cost of reforesting the waste lands of the state. I trust that the report will be of service to the Forestry Commission and to the coming Legislature in attempting to formulate some rational measures for the preservation and restoration of our forests.

The second bulletin, the first of the scientific series, is entitled On the Habits and Instincts of the Solitary Wasps, by Geo. W. and E. G. Peckham. This paper was first sent to me to be published in the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, but the size of the paper, and its scientific value, led me to advise the Commissioners to request its publication as a bulletin of the Survey. Of course, no money was expended by the Survey in the field work for the preparation of the report, and the paper was to be published by the state in any event, either as a part of the volume of the Transactions of the Academy, or in the form in which it actually appeared. The Director felt that the publication of so important a paper as a bulletin of the Survey early in its history would give the Survey a standing among scientific men which it would be slow to reach if it was necessary to wait for the preparation of reports by the assistants of the Survey, especially since the appropriation made to the Survey was in such large measure devoted to economic investigations. I need only say that my expectations have been fulfilled, and that the bulletin is recognized as having very high scientific value as well as great popular interest.

The publication of both of these bulletins was subject to delays which ordinarily attend printing, especially when the series published is new. The manuscript was sent to the printers early in the current year, but it was not until August that the work was finally completed. Delays of various kinds interposed, without fault of anyone, so that the printing and proof reading dragged out over an unusually long time. Many questions arose which had to be referred to the Printing Commissioners, as well as to myself, and the constant necessity for reference back and forth added to the delays. This printing detained me in Madison during most of the early part of the summer. I found that my absence from the city ordinarily involved stopping the work on these bulletins, as unforeseen questions would arise, which could not be settled in my absence. It has been owing to this fact that my field work during the summer was less than I expected to do.

These two bulletins have been distributed together to members of the Legislature, scientific societies, and to various individuals throughout the state. The larger part of the edition has already been sent out, but a sufficient number of copies remain to supply any demand which is likely to arise during the next year, or possibly more.

There has just been printed by the Survey a small edition of the hydrographic map of Lake Geneva. This is the first of the maps of this character to be issued. The map of the Oconomowoc district, including some 16 lakes, is now ready for the printer, and will be followed by the maps of the other lakes in rapid succession.

I ought not to close this section of my report without a warm recognition of the aid given me by the Commissioners of Public Printing and by the Printing Clerk in the publication of these reports.

V. PLANS FOR THE FUTURE.

The Survey has received from the state for the payment of salaries and expenses the sum of $5,000 per year. I think that the money has been wisely expended on the whole. Certainly, an amount of work has been accomplished quite beyond what I had expected from so small a sum of money. It is obvious, however, that the sum is so small that no thorough-going survey of the state can be completed within a reasonable time, unless the income of the Survey is greatly increased. In geology, for example, the Survey has kept one man in the field and he has been able to cover perhaps a thousand square miles of that region of the state which has never been accurately studied. There are nearly 25,000 square miles which are in this condition, and unless a much larger force can be put to work, it will require many years to complete the survey of the geology of the northern part of the state alone. The Survey ought to be able to put into the field, not one man, but at least one party of considerable size, and it would be far better if two such parties could be kept in the field.

In addition to these general considerations there are special reasons why the geological work of the Survey should be extended. The interest in copper mining in Douglas county has greatly developed within the past year, and undoubtedly a large amount of prospecting will be done in that region, in the immediate future. The geology of this region ought, therefore, to be carefully studied at the earliest practicable date. It is not possible for a geological survey to undertake the work of the prospector, and that work should not be attempted by the Survey, but the geologist can aid the prospector by indicating the regions where prospecting is most likely to reach successful results, and also by the equally important service of indicating the areas within which it is useless, or nearly useless, to prospect. As indicated earlier in this report, very large sums of money have been spent in the area around Wausau and Merrill in unsuccessful prospecting in places where a competent geologist would have seen that no mine could be found. The sums of money so wasted in that small region are more than enough to pay the entire expense of a vigorous geological survey for many years. (See p. 16.)

While I desire to extend the work of the Survey to Douglas county, I should be very sorry to abandon the extension of the Survey in the region already undertaken in Marathon county, and I would recommend that two geological parties be kept in the field during the coming seasons, and, if practicable, be maintained until the geology of the northern part of the state has been carefully worked out. It will require about $2,500 per year to maintain each of these parties, or a total of $5,000 annually.

In the direction of economic geology, the most important topic to be treated, next to that of the building stones, is that of the kaolins, the clays, and the clay industries of the state. This, however, is a more difficult subject to work out than that of the building stones, because a large amount of chemical and other scientific investigation is necessary, and also because the industries themselves are so numerous and scattered all over the state. It is necessary also that the investigation, when once undertaken, should be carried on vigorously and rapidly so that a report may be issued within a reasonable time, and while the statistics collected are still fresh. If the work on the clays is to be carried on in this manner, it will require an expenditure of about $3,500 per year for at least two years, in order that a report may be properly prepared.

Another subject which should be carefully investigated is the suitability of the rocks in the southern part of the state for use as road material. The subject of "good roads" is now prominently before the people, and undoubtedly the construction of such roads on a large scale will be undertaken within a very few years. When the building of these roads begins it will be a matter of great importance to the communities undertaking their construction to know exactly the relative value as road material of the various classes of rock which are available. The investigation of this subject will require considerable time and the expenditure of a moderate sum of money. Suitable machinery should be purchased for conducting the experiments, and $1,000–$1,500 expended annually in conducting the tests. The knowledge of our rocks which will thus be acquired will undoubtedly be needed before the Survey can furnish the information even though the study is begun at once.

The third subject of economic interest, upon which work should be undertaken, is the study of the natural waters, especially those of the southern part of the state. Questions of water supply are now pressing upon all of our larger communities and many of the smaller ones in this region, and the communities should have the guidance which would be afforded by a careful survey of the actual and possible sources of water supply. Careful sanitary, chemical, and biological analyses should be made of the waters of lakes and streams of the southern part of the state, and also of the artesian waters, the spring waters, etc. This Survey should also gauge the flow of streams which may be drawn on as sources of water supply, and bring together all of the information which is needed by the state in this direction. The lakes should also be carefully studied with reference to their possibilities in regard to fish culture. A beginning of this study has been made by the preparation of hydrographic maps of the more important lakes of the southern part of the state, which will serve as a basis for the further investigation of these waters. From every point of view, the waters of the southern part of the state constitute that natural resource whose investigation is most necessary at the present time; the resource from which the citizens of the state are at present receiving large returns, and from which still larger returns will be received in the future.

In order to carry on this investigation, it will be necessary to employ the services of a chemist and biologist, as well as several assistants. The state of Illinois is devoting to this general line of investigation of waters the sum of more than $5,000 annually, and an equal sum should be spent in this state.

These three lines of work, together with topography, constitute the most important directions in which the work of the Survey should be turned. There are other matters, however, of smaller importance, which should not be neglected. I am constantly appealed to for information regarding the mining industries of the state. I am, however, quite unable to answer these inquiries, since there is no means provided by which the statistics of mining in this state can be collected. The collection and collation of such statistics would occupy a portion of the time of a clerk or similar person and would involve expense which the Survey has at present no means of meeting. The work could well be undertaken, however, in connection with some of the larger subjects of investigation.

Another topic which the Survey should undertake, is the preparation of the history of the exploitation of the great forests of the state. Mr. Roth's bulletin, which has been published by the Survey, gives a sketch of the present condition of the forests, but they have been a prime source of wealth to the state during the past half century. It is still possible to obtain the history of the forests and of their exploitation, but the time will soon be past when that history can be obtained. The treatment of the subject demands the employment of scientific methods, as well as historical, and the work belongs pre-eminently to this Survey. I should be glad to be able to begin at once the collection of data for such a history.

All of these subjects are of economic importance, or immediately allied to subjects which are economic. To investigations of this sort a major part of the money appropriated by the state for the Survey must always be devoted as it has been in the past; but the Survey would fail to perform its duty to the state if it did not regard a diffusion of the knowledge of nature as one of its main functions. It should be the duty of the Survey to prepare reports on the plants and animals of the state, looked at both from a scientific and popular point of view; to report on the physical geography, geology, and paleontology. In many cases the field work will have to be done almost or wholly without compensation, but the Survey should be ready to aid such studies when of sufficient importance by the payment of expenses, and in similar ways, and should also be ready to publish the results of such investigations when completed. Nor will the Survey complete its duty unless a reasonable proportion of the money granted by the state is devoted to furthering these investigations, which may seem not to have economic value at once, but which experience has shown are sure to become of value, not merely to the intellectual, but to the material progress of the state.

There is another object to which a considerable sum of money should be devoted, which seems to me of importance equal to any of those which I have named. I refer to the matter of topography. In all civilized countries of the world, a carefully prepared topographic map is regarded as of first importance, and to the preparation of such a map large sums of money are devoted by all European countries, and by the more advanced states of the Union. Such maps have been completed in Massachusetts, New Jersey, and Connecticut, and are in progress in New York and in other states. The United States government, acting through the Geological Survey, will appropriate to the subject of topography a sum equal to that which is devoted to it by the state. A small portion of the state has already been surveyed by the U. S. G. S., and a small amount of work has been done in the region of the Dells and Devils lake during the past season. The Survey ought to be able to appropriate to this subject at least $2,500 per year, which, with an equal sum from the national government, would enable the preparation of a topographical map to go on steadily, if not so rapidly as we could wish. I have found some persons reluctant to believe that topography really possesses the great importance which is attributed to it, but in no part of the world where such maps have been made are they regarded as having anything less than the greatest possible value. I am sure that as soon as such work can be begun and carried out sufficiently to show the value of the survey to the people, there will be no further doubt in the minds of any of the real value of such work. In my own judgment the time is ripe for a careful survey of the southern part of hte state, and the survey will hardly reach the northern region in advance of the progress of settlement which will make its extension necessary to that region. In the progress of the survey of the lakes of the southern part of the state during the past year, the gross inaccuracies with which the county and other maps are filled have been strikingly impressed upon me. They are certainly not worthy of a country which regards itself as civilized.

If all of these plans are carried out, even on a small scale, a sum of not less than $17,000 per year will be necessary.

Respectfully submitted,

E. A. Birge,
Superintendent.

FINANCIAL REPORT, FROM SECRETARY OF STATE.

GEOLOGICAL SURVEY.

Warrants issued June, 1897—Sept. 30, 1898.

Buckley, E. R., salary	$66 66
Buckley, E. R., expenses	152 66
Buckley, E. R., mdse	20 05
Cheney, L. S., expenses	137 06
Buckley, E. R., expenses	45 39
Buckley, E. R., expenses	109 85
Buckley, E. R., salary	66 67
Marsh, D. C., services	56 00
Collie, G. L., services	105 00
Collie, G. L., expenses	7 40
Weidman, S., expenses	71 87
Weidman, S., salary	66 66
Pickarts & Nicodemus, mdse	35 00
Birge, E. A., expenses	53 45
Buckley, E. R., expenses	77 67
Buckley, E. R., salary	66 66
Cheney, L. S., expenses	51 93
Gordon, J. C., services	2 77
Marsh, C. D., expenses	25 70
Marsh, C. D., expenses	9 09
Hollister's Pharmacy, mdse	15 49
Haack, Wm., mdse	21 44
Nicholson, D. O., services and expenses	52 50
Roth, F., expenses	103 20
Weidman, S., salary	84 06
Weidman, S. expenses	54 06
Buckley, E. R., expenses	54 94
Buckley, E. R., expenses	73 84
Buckley, E. R., salary	66 67
Roth, F., expenses	111 40
Weidman, S., expenses	38 31
Weidman, S., salary	66 66
Van Hise, expenses	12 23
Ritchie, E. S., & Sons, mdse	61 75
Cheney, L. S., expenses	14 85
Nicholson, D. P., expenses	9 37
Collie, G. L., expenses	25 25
Weidman, S., expenses	49 46
Weidman, S., salary	66 66
Buckley, E. R., salary	100 00
Buckley, E. R., expenses	46 52
Weidman, S., salary	66 66
Weidman, S., expenses for mdse	21 60
Roth F., expenses	195 65
Collie G. L., mdse	37 00
Emerton, J. H., services	60 00
Ohm's Son, Fred C., services	22 90
Weidman, S., salary	66 66
Buckley, E. R., salary	66 66
Coombs, E. C., services	42 00
Birge, E. A., expenses	4 75
Birge, E. A., expenses	56 97

Buckley, E. R., expenses	$17 61
Buckley, E. R., salary	66 67
Chamberlain, P. F., services	12 50
Dretzgen Co., Eugene, services	8 25
Ganthie, W. F., board for men	13 30
Healy, P., labor	17 00
Hartmann, P., services	2 19
Hogg, J. R., services	19 50
Johnson, O., labor	26 53
Kratcsch, H., services	11 60
Lottes, W. G., services	2 50
Lottes, W. G., services	6 00
Lewis, A. W., services	10 00
MacGregor, W. F., services	21 00
Mutchler, I, services and mdse	17 25
Mutchler, C. B., services	2 50
Ohms' Son, Fred C., mdse	84 80
Ohms' Son, Fred C., services	12 40
Schubert & Son, services	5 80
Smith, L. S., expenses	20 65
Trippe, H. M., labor	26 88
Thorgeson, C. T., services	13 12
Williams, L. A., services	15 90
Weidman, S., salary	66 66
Buckley, E. R., salary	66 66
Coombs, E. C., services	55 00
Keat, J., expenses	15 00
McCabe, J., expenses	12 00
Weidman, S., salary	66 66
Marsh, C. D., expenses	41 15
Marsh, C. D., services	14 90
Trippe, H. M., expenses	86 01
Trippe, H. M., services	70 00
Trippe, H. M., services	174 97
Smith, L. S., services and mdse	35 90
Buckley, E. R., salary	66 66
Buckley, E. R., expenses	12 30
Nommensen, R. A., services	6 25
Ohms' Son, Fred C., services	2 70
Stone, M. B., services	2 40
Smith, W. N., services	29 87
Weidman, S., salary	66 66
Buckley, E. R., salary	66 66
Denniston, F. K., services	63 00
Gerlach, F. A., services	11 40
Gerlach, F. A., services	10 20
Harper, B., services	19 60
Klug, L. J., services	6 75
MacGregor, W. F., services	4 40
Riley, E. F., services	20 00
Smith, L. S., services	40 70
Smith, W. M., services	24 25
Weidman, S, salary	66 66
Buckley, E. R., salary	66 67
Buckley, E. R., expenses	52 10
Dow, L. A., services	16 12
Denniston, F. K., services	35 00
Green, H. J., services	15 00
Gerlach, T. A., services	3 80
Nommensen, R. A., services	1 00
Smith, W. N	6 50

Smith, L. S., services	$33 40
Weidman, S., salary	66 66
Weidman, S., expenses	39 95
Buckley, E. R., salary and expenses	87 79
Weidman, S., salary	66 66
Smith, L. S., services	31 70
Ballauf, D., mdse	12 00
Gordon, J. C., services	6 45
Buckley, E. R., salary and expenses	78 37
Smith, L. S., services and expenses	66 45
Weidman, S., expenses	50 45
Wiedman, S., salary	66 67
Birge, E. A., expenses	33 71
Cheney, L. S., expenses	66 63
Marsh, C. W., expenses	29 15
Nicholson D. P., services	25 43
Smith, W. N., services	14 63
Smith, W. N., services	24 13
Birge, E. A., expenses	69 60
Buckley, E. R., salary	66 66
Daniells, W. W., services	203 10
Cheney, L. S., services	227 25
Denniston, F. K., services	14 10
Denniston, F. K., services	62 25
Mills, L. W., services	5 00
Marsh, C. D., expenses	34 40
Nicholson, D. P., services and expenses	84 84
Ritchie, E., Sr., Sons, mdse	12 75
Smith, L. S., services and expenses	124 49
Smith, L. S., expenses and services	128 74
Tension Envelope Co., mdse	21 00
Weidman, S., salary	66 65
Weidman, S., expenses	47 54
Total to September 30. 1898	$6,821 16